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ECONOMIC SUSTAINABILITY IN THE PALM OIL SECTOR: A BIBLIOMETRIC REVIEW USING R STUDIO

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ABSTRACT

The growth of the global palm oil industry with the call to balance its significant economic contributions with pressing sustainability challenges has been a subject of debate for decades. In line with this pressing need, this study aims to examine the evolution of academic publications on economic sustainability in the palm oil industry through a bibliometric review of scholarly literature spanning from 1996 to 2025. The study analyses publication trends across different dimensions, including authorship, institutional affiliations, geographical distribution, and evolving topic trends. By assessing the trajectory of academic discourse, this study identifies key shifts from production-focused studies to research emphasising environmental impact mitigation, policy frameworks, and sustainable certification mechanisms. Findings from the review suggest that interdisciplinary collaborations have increased over time, reflecting a growing recognition of the complex interplay between economic growth and sustainability in the palm oil sector. In addition, this review highlights gaps in existing research, particularly concerning smallholder economic resilience and policy harmonisation. The study contributes to the academic and policy discourse by providing insights into future research directions that can support sustainable industry practices.

Keywords: bibliometric analysis, economic, palm oil, research trend, sustainability.

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INTRODUCTION

The palm oil industry plays a crucial role in the global agricultural economy, serving as a key source of edible oils and biofuels. However, the rapid expansion has raised concerns over environmental degradation, social implications, and economic sustainability (Hassan et al., 2025). The intersection economic growth and environment sustainability within this industry has become a focal point for researchers and policymakers alike. As demand for palm oil continues to rise, ensuring a balance between economic growth and environmental responsibility is paramount (Parsons et al., 2020).

Sustainability in the palm oil sector is largely influenced by regulatory frameworks and voluntary certifications such as the Roundtable on Sustainable Palm Oil (RSPO). These measures aim to promote environmentally appropriate and economically viable production practices (Organisation for Economic Co-operation and Development [OECD], 2025). Several studies have highlighted that integrating sustainable practices, such as biogas energy utilisation and compost production, can enhance economic sustainability while reducing the carbon footprint of palm oil mills (Nasrin et al., 2024). Furthermore, sustainability certifications have demonstrated a positive impact on financial profitability. Hence, this provides

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economic incentives for companies to comply with stringent environmental standards (Hafizuddin-Syah et al., 2018).

Despite these efforts, challenges persist in ensuring a truly sustainable and economically viable palm oil industry. Some scholars (such as Ayompe et al. [2025], Mohd Noor et al. [2017] and Mukhlis et al. [2025]) argue that sustainability frameworks need further refinement to address the complex socio-economic dynamics of smallholder farmers and large-scale plantations. Additionally, evaluating the long-term financial benefits of sustainability initiatives remains an ongoing contending question (Mareeh et al., 2023). Given the critical need to balance palm oil industry growth with sustainability advocacy, previous study within this specific context has become highly debated. The findings from these past studies not only just providing the needed insight but to also provide future research direction.

A bibliometric review on economic sustainability in the palm oil industry is significant as it maps the trends, and research gaps in this field. By analysing existing literatures, the study can highlight evolving debates, policy implications, and technological advancements. Its contribution lies in identifying critical knowledge areas, guiding future research directions, and informing stakeholders-policymakers, industry players, and academics-on balancing economic growth with sustainable practices in palm oil production.

The remainder of the article will be structured as follows. The article will begin with the introduction that include a summary of the body of knowledge observed. Next, the research questions are pre-determined to ensure that the reviews are relevant to be used in addressing the questions in need. Subsequently, the methodology used in this article will be explicitly explained and illustrated. The output of the review analysis will then be reported in the results finding. A further discussion on the reviews finding will be provided subsequently. The final section concludes the research by contributing the future study directions and to highlight on the literature gap.

MATERIALS AND METHODS

For the purpose of this review, the search strategy of PRISMA (Preferred Reporting Items for Bibliometric reviews) was employed to gather relevant literature for the bibliometric analysis. The use of PRISMA will extensively scan all literature published on the subject to find answers to the clearly defined research question, and to that end use various inclusion and exclusion criteria to identify the reports to be included in the review, and then synthesise the findings (Yun et al., 2023). PRISMA provides a structured framework that enhances the clarity and reproducibility of bibliometric reviews, making it a widely accepted standard in the field (Page et al., 2021). The well-developed search strategy will be employed on the Scopus database in recognition of the credibility of Scopus as one of the largest academic literature databases with close to 50 million records of around 5,000 publishers (Grimaldi et al., 2017).

Using bibliometric, text-mining, and visualisation technologies, the following research questions (RQ) are used to illustrate the review process and activities. The methodology procedures utilised in this investigation, including the searching procedure, data collecting, extraction and analysis.

The search strategy begins by filtering and refining the literature by a combination of keywords. The preliminary search using the keywords of "Palm Oil" retrieved about 41,668 publications. By further filtering the search result with additional keyword of "Sustainability", the search retrieved about 2,460 publications. Further narrowing the search with another important key term of 'Economic Sustainability' has gathered 720 publications. By further restricting the article to English language publications only, 720 articles were obtained. *Table 2* illustrated the search inclusion and exclusion criteria used in refining the search for relevant publications. *Figure 1* showed the PRISMA strategy employed in searching, screening, and refining articles for the bibliometric review.

TABLE 1. RESEARCH QUESTIONS

No.	Research questions	Analysis protocol
1	What is the current state and trend of publication on the topic of Economic Sustainability in the Palm Oil Industry?	• Trend of Publications • Annual Scientific Production • Document by Subject Area • Document by Type • Annual Citations Per Year
2	How has the publication evolved on the topic of Economic Sustainability in the Palm Oil Industry?	• Document by Author • Document by Affiliation • Document by Country

TABLE 2. SEARCH CRITERIA

Scopus category	Searching criteria	No. of article
Keywords 1	"Palm Oil"	39,774
Keywords 2	"Sustainability"	2,436
Keywords 3	"Economic Sustainability"	720
Document type	All types of publication	720
Language	English	720

RESULTS AND DISCUSSION

What is the Current State and Trend of Publication on the Topic of Economic Sustainability in the Palm Oil Sector?

Figure 2 showed the trend of the publications screened and extracted from the Scopus database. The publications that meet all the inclusion criteria has been found spanning in between the years of 1996 to 2025 with the total of 720 documents. From *Figure 2*, the trend of publications has clearly illustrated a growing academic interest in the economic sustainability of the palm oil industry. The dataset reveals that the research activity on the topic of economic sustainability concerning palm oil industry has increased significantly in the past decade. This increase is likely attributable to heightened global awareness regarding the environmental and economic challenges associated with palm oil production (Hilmi et al., 2025; Judijanto, 2025). The rising demand for sustainable palm oil, coupled with regulatory policies and consumer awareness, has spurred academic studies into this field (Chang et al., 2025; Narayanan et al., 2024).

Meanwhile, *Figure 3* has presented the annual scientific production analysis, with clear rise of the number research publications per year. A closer examination of these trends clearly indicating an increasing interest of scholars on the economic sustainability of palm oil sector. The sharpest rise is observed between 2022 to 2024, with large number of papers being published in each of these years. This sudden surge can be attributed to global initiatives on sustainable agriculture, stringent environmental policies regulations, and industry-driven efforts to promote responsible palm oil production (Yeoh et al., 2025). This has further underscored how sustainability challenges from rapid palm oil expansion have prompted policy-driven strategic responses and need for inclusive green productivity, linking regulatory issues to sustainability research (Haryani et al., 2025). The growing scientific production highlights the increasing importance of economic sustainability in the palm oil sector within academic discussions.

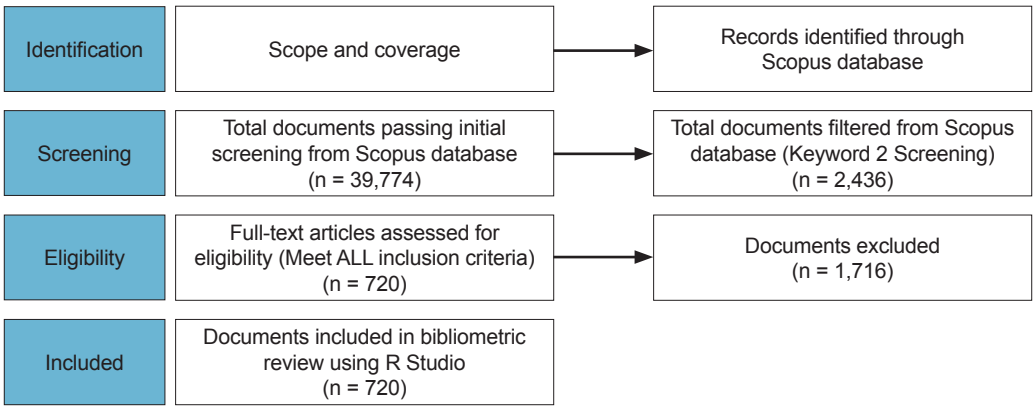

Figure 1. The PRISMA diagram used to find, screen, and select articles.

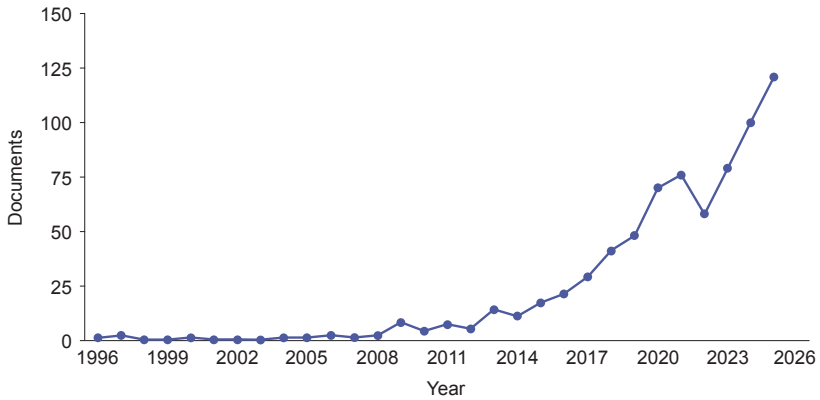

Figure 2. Trend of publications (1996–2025).

The distribution of documents by subject area, as depicted in *Figure 4*, underscores the multidisciplinary nature of research on economic sustainability in the palm oil sector. The majority of publications fall within environmental science (22.6%), which is expected given the pressing ecological concerns associated with palm oil production. A significant number of publications also fell under the field of energy (13.5%) suggesting that the palm oil sector's direct involvement in bioenergy, its environmental impacts linked to energy use and emissions, and the growing focus on renewable energy solutions. This explained the reason for palm oil sector researches to be frequently examined from an energy perspective that allows exploration of how it can become more sustainable and economically viable within the broader energy and environmental context. This is followed by large publications from the engineering field, revealing that the study of the economic sustainability in palm oil industry has been widely examined within engineering research domain. Agricultural economics (9.4%) is another prominent subject area, as researchers examined the financial feasibility and profitability of sustainable palm oil practices. Other disciplines such as social science (8.8%) similarly published in this research area, thus reflecting growing corporate interest in sustainable supply chain practices. This diversification in research disciplines implied that the sustainability of palm oil is not only considered as an environmental issue but also poses significant economic and policy concern as well. The involvement of multiple fields suggests that addressing the sustainability challenges of the palm oil sector requires an interdisciplinary approach.

Figure 5 showed the analysis of the types of documents and revealing that journal articles constitute the largest proportion of published documents, followed by conference papers and reviews. The large percentage of journal articles (59.7%) signifies a strong emphasis on rigorous, peer-reviewed research that contributes to the academic body of knowledge on economic sustainability in the palm oil sector. Conference papers (comprised of 15.7%), on the other hand, indicate ongoing discussions and emerging research themes that are presented at international forums. Review articles (12.4%) play a critical role in synthesising existing research and providing comprehensive insights into past findings, gaps in the literature, and future research directions. The presence of various document types highlights the evolving nature of research in this field, with a combination of theoretical discourse and empirical analysis. This diversity also suggests that stakeholders, including policymakers and industry practitioners, can access research in multiple formats, aiding in the application of academic insights to real-world sustainability challenges.

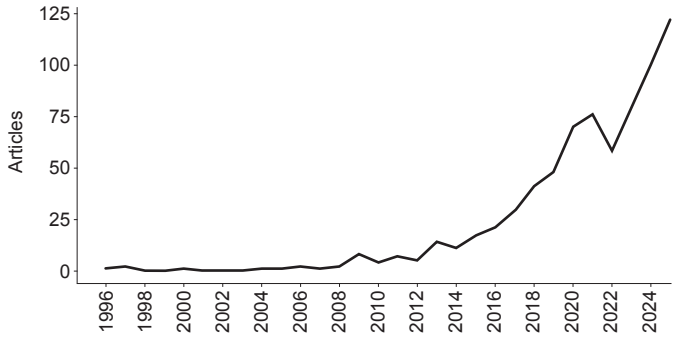

Figure 3. Annual scientific production (1996–2025).

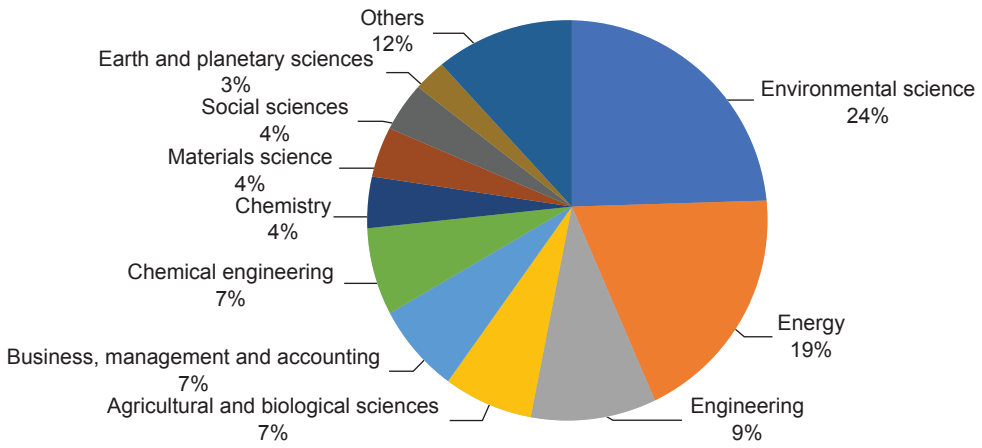

Figure 4. Documents by subject area.

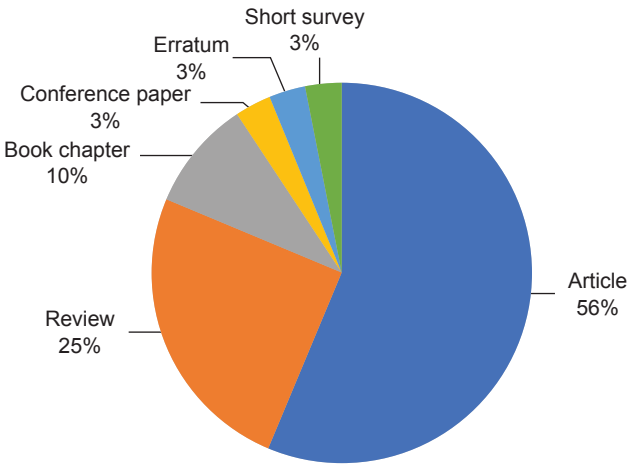

Figure 5. Documents by type.

Table 3 provides valuable insights into the impact of publications over time by demonstrating the citation analysis. The citation data indicates that older publications, particularly those from 2006 and 2018, have the higher mean citations per article, demonstrating their foundational role in shaping subsequent research. The relatively high citation count of publications from 2010 suggests that they contain influential findings or frameworks that have been widely referenced in later studies. In contrast, more recent publications, particularly those from 2023 to 2025, have lower citation counts due to their recent emergence in academic literature. This is a common trend in citation analysis, as it takes time for new research to be cited by subsequent studies. The variability in citation trends also reflects the differing levels of academic influence and relevance of publications in this field. Additionally, peaks in citation activity often coincide with periods of increased global discourse on sustainability, further reinforcing the importance of external socio-political factors in shaping research impact.

TABLE 3. ANNUAL CITATIONS PER YEAR (1996–2025)

Year	Mean TC per art	N	Mean TC per year	Citable year
2025	1.58	122	0.79	2
2024	7.14	100	2.38	3
2023	12.68	79	3.17	4
2022	16.98	58	3.40	5
2021	28.49	76	4.75	6
2020	23.47	70	3.35	7
2019	30.77	48	3.85	8
2018	42.44	41	4.72	9
2017	33.90	29	3.39	10
2016	39.29	21	3.57	11
2015	40.94	17	3.41	12
2014	66.18	11	5.09	13
2013	60.57	14	4.33	14
2012	85.80	5	5.72	15
2011	76.57	7	4.79	16
2010	146.50	4	8.62	17
2009	53.38	8	2.97	18
2008	33.00	2	1.74	19
2007	19.00	1	0.95	20
2006	98.50	2	4.69	21
2005	10.00	1	0.45	22
2004	0.00	1	0.00	23
2000	43.00	1	1.59	27
1997	20.50	2	0.68	30
1996	3.00	1	0.10	31

How has the Publication Evolved on the Topic of Economic Sustainability in the Palm Oil Sector?

Figure 6 showed the analysis of documents by author that indicated key scholars contributing extensively to the discourse on palm oil sustainability. Over the years, certain authors such as Lam, H. L., Lim, J. S., Hashim, H. have emerged as leading researcher, with a consistent increase in multi-author collaborations. Early research was dominated by a few prominent figures, but as awareness of sustainability concerns grew, a more diverse set of scholars entered the field. Several highly cited authors have concentrated on specific subtopics such as life cycle assessments (LCA), the socioeconomic impact of sustainable palm oil production, and corporate sustainability reporting. The increased collaboration among authors suggests a multidisciplinary approach, integrating different perspectives from environmental science, social science, economics, and business. Additionally, the presence of co-authored papers between academia and industry professionals highlights the practical implications of research findings, demonstrating a trend towards applied research aimed at policy and industry implementation.

The subsequent *Figure 7* showed the documents by affiliation covering the years 1996 to 2025. Academic institutions and research centers have

played a critical role in advancing knowledge on sustainable palm oil production. Universities from Southeast Asia, particularly in Malaysia and Indonesia were found to dominate the research landscape, reflecting the regional significance of the palm oil sector. Notably, affiliations with environmental and economic research institutes have increased, indicating an interdisciplinary approach to studying economic sustainability. For example, local Universiti Kebangsaan Malaysia (UKM) and Universiti Putra Malaysia (UPM) have consistently contributed to the discourse, focusing on sustainable farming practices, environmental impact assessments, and economic feasibility studies.

Meanwhile, Western institutions particularly from Europe and North America, have collaborated with Southeast Asian researchers, often examining the global implications of palm oil production on biodiversity and climate change. Government-affiliated research bodies and international organisations, such as the RSPO, have also contributed significantly to the research landscape. These affiliations highlight a growing convergence between academic research and policy-making, with universities and organisations increasingly focusing on policy interventions, certification mechanisms, and responsible production standards.

Figure 8 indicated the number of publications by countries. The analysis clearly illustrated that researches on palm oil sustainability was found to predominantly concentrated in countries with large palm oil production industries, such as Malaysia and Indonesia. Whereas, contributions from European and North American institutions have also risen, often focusing on the environmental impacts of palm oil supply chains and consumer-driven sustainability initiatives. Malaysia and Indonesia, as the world's leading palm oil producers, have seen a surge in research focusing on improving production efficiency while minimising environmental degradation. Studies from these countries emphasise sustainable land management, smallholder inclusion in Certified Sustainable Palm Oil (CSPO) programs, and the economic trade-offs of sustainability practices.

Meanwhile, European researches particularly from the Netherlands, Germany, and the United Kingdom, tends to investigate supply chain transparency, regulatory policies, and consumer perceptions of sustainable palm oil. The presence of European-funded sustainability initiatives in palm oil-producing countries has led to collaborative research efforts aimed at reducing deforestation and promoting eco-friendly production. Other countries, such as the United States and Australia, have contributed research on market dynamics, investment risks, and corporate responsibility related to the palm oil industry. The expanding geographical scope of research suggests a growing recognition of palm oil's global economic and environmental impact, further reinforcing the need for international collaboration in addressing sustainability challenges. Although, Prasetyani et al. (2024) conducted a bibliometric analysis of palm oil business and environmental quality nexus, identifying trends related to environmental impacts and sustainability but they did not explicitly map to the economic sustainability topics. Similarly, Nasirly et al. (2024) conducted bibliometric review on life-cycle assessment in the palm oil industry systematically maps environmental sustainability research and methodological trends, yet does not foreground economic outcomes or economic performance dimensions.

By closely analysing the trend topics, the findings highlighted a shift in research priorities. Early publications primarily discussed economic feasibility and industry expansion, while more recent studies focus on sustainable certification systems, carbon footprint reduction, and alternative agricultural practices. The progression of research topics reflects both industry developments and external pressures from environmental organisations, governments, and consumers. Between 1996 and 2010, research centered around maximising yield efficiency, cost-benefit analyses, and global trade dynamics. Sustainability was often discussed as a secondary concern, with primary emphasis placed on economic expansion. As environmental concerns gained prominence, particularly following major deforestation incidents and criticisms from environmental NGOs, research from 2010 to 2020 increasingly addressed issues of sustainability certification, carbon emissions, and corporate social responsibility.

Post-2020, emerging topics have included blockchain for supply chain transparency, smallholder sustainability programs, and global policy alignment with environmental goals. The role of financial institutions in promoting sustainability through green financing mechanisms has also gained traction. Research now explores the integration of artificial intelligence (AI) and remote sensing technologies for monitoring deforestation and optimising sustainable palm oil practices. Moreover, interdisciplinary research is becoming more common, bridging economics, environmental science, and technology to propose innovative solutions for achieving economic sustainability. These trends indicate a future research trajectory that will likely emphasise regulatory compliance, technological advancements, and market-driven sustainability incentives.

The trajectory of research in this domain illustrates a growing commitment to balancing economic growth with environmental sustainability. Early research largely focused on

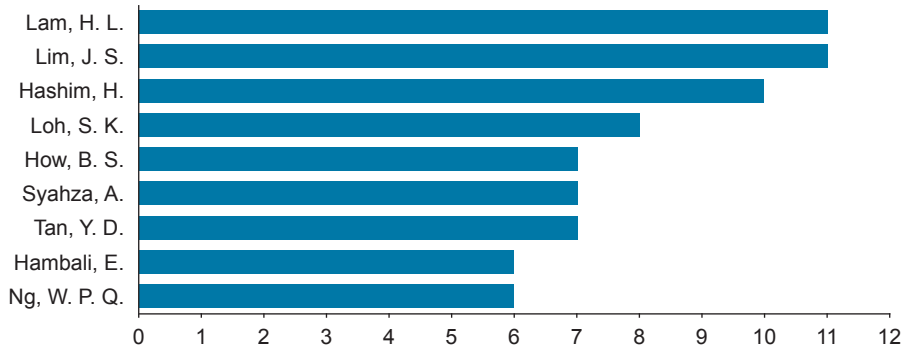

Figure 6. Documents by author (1996–2025).

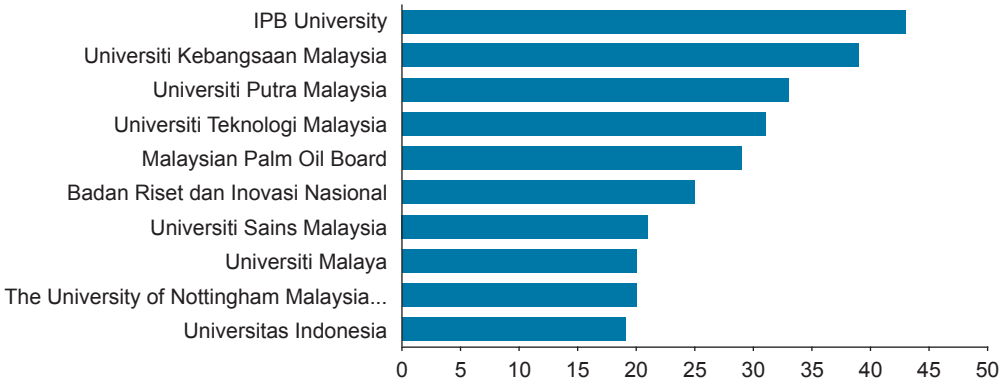

Figure 7. Documents by affiliation (1996–2025).

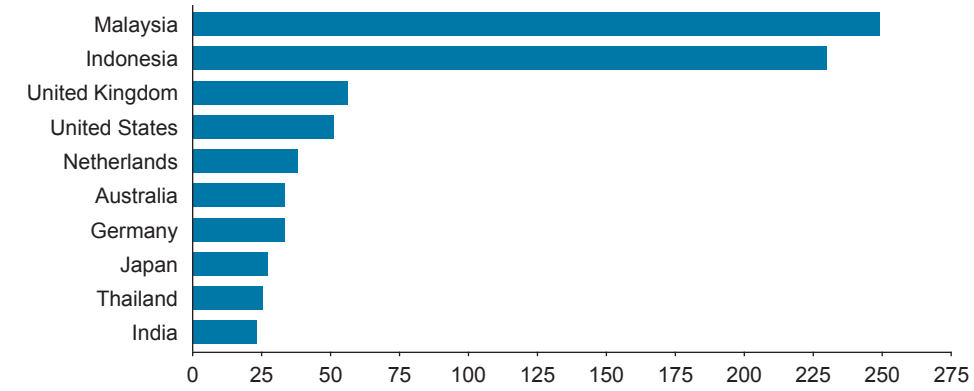

Figure 8. Documents by country (1996–2025).

optimising production efficiency and profitability, with minimal attention to sustainability concerns (Corley & Tinker, 2003). However, as environmental degradation, biodiversity loss, and climate change concerns became more pronounced, the research focus shifted towards sustainable agricultural practices, regulatory frameworks, and corporate responsibility (Gatti et al., 2019).

The increasing number of interdisciplinary collaborations indicates a shift from a purely economic analysis of palm oil production to an integrated approach that incorporates environmental and social factors (Meijaard et al., 2020). Studies on certification mechanisms, such as the RSPO, highlight the role of governance and policy interventions in fostering sustainability (Nupueng et al.,, 2023). Nevertheless, criticisms remain regarding the effectiveness and enforcement of these certification systems, particularly in ensuring smallholder participation (Ekaputri et al., 2025).

Within the economic aspect of sustainability, many past studies had been found to primarily focus on the economic feasibility and expansion initiatives which includes supply chain transparency, smallholder sustainability programs. This review therefore clearly reflected the evolution in research focus-from early works prioritising yield maximisation and trade expansion to more recent emphasis on certification, carbon footprint

reduction, and supply chain transparency. However, the economic implications of these shifts require deeper examination. For example, blockchain-based traceability solutions, while enhancing supply chain integrity, may introduce new technology adoption costs and create barriers for resource-constrained producers unless supported by targeted capacity-building programs and subsidised infrastructure (Abdullah & Alani, 2025; Bui & Le, 2025; Elkoraichi, 2025). In other words, the bibliometric has review underscores a pressing need to amplify the economic dimension of sustainability in the palm oil sector. While environmental science remains the dominant focus, only a modest share of literature addresses agricultural economics (6.8%) and business management (6.8%), pointing to an underutilised area of academic exploration.

Despite these advancements, gaps persist in understanding the long-term economic trade-offs of sustainability interventions. Future research should explore policy harmonisation, particularly aligning national sustainability policies with global climate agreements (Lambin et al., 2018). Moreover, more studies are needed to assess the economic resilience of smallholders under sustainability mandates and market-driven sustainability pressures.

CONCLUSION

This bibliometric review underscores the evolving nature of academic discourse on economic sustainability in the palm oil industry. The findings of this study reveal an increasing research focus on economic sustainability in the palm oil industry. The growing number of publications and citations highlights the academic community's commitment to addressing sustainability challenges. The interdisciplinary nature of the research indicates that sustainable palm oil production is a complex issue that requires insights from environmental science, economics, business, and policy-making.

Additionally, the industry's response to consumer demands for sustainable palm oil warrants further examination. The extent to which sustainability efforts translate into market advantages or economic trade-offs remains a crucial area for research. More longitudinal studies tracking the long-term economic benefits of sustainable practices will also contribute to a deeper understanding of how economic sustainability aligns with environmental sustainability. Overall, this bibliometric review underscores the importance of continued research and collaboration between academia, industry stakeholders, and policymakers. Strengthening the research-practice nexus can enhance policy recommendations and industry strategies, ultimately leading to a more economically sustainable palm oil sector.

Despite this expansion, the bibliometric evidence reveals several specific and underexplored research gaps. First, there is a notable lack of disaggregated economic viability studies, particularly those comparing independent smallholders and scheme smallholders. While smallholders are frequently mentioned in the literature, rigorous comparative assessments of cost structures, income stability, and long-term economic resilience across different smallholder models remain limited. This gap is especially critical given the central role of smallholders in global palm oil supply chains.

Second, although sustainability certification schemes feature prominently in keyword clusters, the literature shows limited empirical evaluation of their actual economic outcomes, such as productivity gains, profitability, and income distribution effects at the producer level. Similarly, research examining the economic impacts of regulatory frameworks tends to be conceptual or policy-oriented, with relatively few outcome-based or country-specific evaluations.

Third, the analysis indicates that technological innovation is often discussed in isolation, with insufficient integration of economic performance metrics. There is a lack of studies assessing whether digital tools, precision agriculture, or traceability technologies generate measurable economic returns alongside sustainability gains, particularly for small and medium-scale producers.

In addition, the findings point to a shortage of region-specific and comparative studies, especially across major palm oil-producing countries. This limit the understanding of how national contexts, governance structures, and market conditions shape the economic effectiveness of sustainability initiatives. Finally, while consumer demand for sustainable palm oil is frequently acknowledged, longitudinal research examining whether sustainability adoption translates into sustained market advantages or economic trade-offs remains scarce.

By identifying these granular, data-driven gaps, this bibliometric review contributes beyond mapping publication trends and offers a clearer agenda for future research. Addressing these missing areas can strengthen the research-practice nexus and support more targeted policy interventions and industry strategies, ultimately advancing a palm oil sector that is both economically viable and sustainable.

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